XILINX JTRS SDR Announcement
February 22, 2006
Frequently Asked Questions (FAQ)

1. What is SDR?

SDR (Software Defined Radio) is an emerging technology that spans all radio network topologies in the commercial, military and civil government sectors, and enables highly flexible solutions with benefits to operators, manufacturers and consumers.
(Source: SDR Forum)

As adopted by the SDR Forum, the term SDR is used to describe radios that provide software control of a variety of modulation techniques, wide-band or narrow-band operation, communications security functions (such as hopping), and waveform requirements of current and evolving standards over a broad frequency range. The frequency bands covered may still be constrained at the front-end requiring a switch in the antenna system.

According to the FCC: "In a software-defined radio, functions that were formerly carried out solely in hardware, such as the generation of the transmitted signal and the tuning and detection of the received radio signal, are performed by software that controls high-speed signal processors."

2. What is JTRS?

JTRS stands for Joint Tactical Radio System. Considered a pivotal Department of Defense (DoD) transformational program, JTRS is a Defense Department-wide initiative to develop a family of revolutionary software-programmable tactical radios that will provide the war fighter with voice, data and video communications, as well as interoperability across the joint battle space. Current radio systems lack interoperability across the spectrum and have insufficient bandwidth to meet present and future communications challenges. The solution for interoperability is an all service radio and a new wideband networked waveform with the ability to provide mobile networked-connectivity across the battle space while providing compatibility with the current waveforms in use by the DoD today.

3. What are JTRS Waveforms?

Interoperability within JTRS will be supported through the use of software-based waveforms. The waveform software developed for JTRS includes not only the actual radio frequency (RF) signal in space, but the entire set of radio functions that occur from the user input to the RF output and vice versa. For example, in the transmitting JTRS, the waveform software will control the receipt of the data (either analog or digital) from the input device and manage the encoding. The encoded data is passed to the encryption engine. The resultant encoded/encrypted data stream is modulated into an intermediate frequency (IF) signal. Finally, the IF signal is converted into a RF signal and transmitted to the antenna. These same functions will be reversed in the receiving JTRS with the ultimate output of the data to the user.

JTRS waveforms will be "portable" between hardware platforms. Portability means the basic waveform software will be developed in such a way that it may be "ported" to multiple hardware platforms and operating systems. Portability is an underlying tenet of the JTRS and its development based on the SCA. This reduces the cost associated with development of JTRS, since each waveform is built only once, and also increases the potential for interoperability among JTRS hardware.

4. What is an SCA?

SCA stands for Software Communications Architecture. The functionality and expandability of the Joint Tactical Radio System is built upon the Software Communications Architecture (SCA). The SCA is an open architecture framework that tells designers how elements of hardware and software are to operate in harmony within the JTRS. It governs the structure and operation of the JTRS, enabling programmable radios to load waveforms, run applications, and be networked into an integrated system. Design engineers use the SCA definition document just as an architect or planner uses a local building code to design and build homes.

Through adherence to standards detailed in the SCA definition document, both hardware and software designers know what equipment and programs to design. The SCA does not tell designers how to design their equipment and programs. Thus, JTRS compliant radios and networked systems, when designed in compliance with the SCA, will meet JTRS standards for interoperability, just as properly designed plumbing or electrical systems meet local codes for construction and safety.

An SCA OE (Operating Environment), which is the software stack running on the 405, comprises:

- POSIX-compliant RTOS (in this case, Green Hills INTEGRITY)
- CORBA ORB (in this case, OrbExpress from Objective Interface Systems)
- SCA Core Framework (from CRC – Communications Research Centre in Ottawa)

The SCA leverages the CORBA ORB for standard message passing, and uses POSIX calls to the RTOS for standard scheduling.

Having the SCA OE running on the embedded 405, rather than an external general- purpose processor, can result in power savings in the modem.

5. What is meant by Shared Resources Model?

Partial reconfiguration of FPGAs is the requisite enabling technology to support a shared resources model, as opposed to a dedicated resources model. In a dedicated resources model, an SDR modem requires N sets of dedicated processing resources (i.e., N FPGAs, N DSPs, N GPPs) to support N waveforms. This inefficient implementation leads to a higher power, more expensive modem that does not scale well. In a shared resources model, less processing resources are required since multiple waveforms can be supported on a single set of processing resources. The result is a lower cost modem that consumes less power.

6. What is Partial Reconfiguration?

Partial reconfiguration is the ability to reconfigure select areas of an FPGA anytime after its initial configuration. You can do this while the design is operational and the device is active (known as active partial reconfiguration) or when the device is inactive in shutdown mode (known as static partial reconfiguration).

By taking advantage of partial reconfiguration, you gain the ability to:

- Adapt hardware algorithms
- Share hardware between various applications
- Increase resource utilization
- Provide continuous hardware servicing

Partial reconfiguration provides many benefits to customers:

- Lower power and cost through sharing the same resources for multiple waveforms
- Reduces modem size and weight as fewer devices lead to a smaller form factor
- Competitive advantage versus competing solutions that do not allow partial reconfiguration (lower power, cheaper, smaller, lighter)

With Xilinx® FPGAs, partial reconfiguration can be controlled using on chip processors such as the PowerPC™ 405 or MicroBlaze™ cores or external microprocessors. The on-chip PowerPC 405 processor can run any flavor of OS, including an RTOS as required by the SCA Operating Environment. A hard MMU is provided to keep applications separate and prevent accidental system crashes. This is a unique advantage versus the competition.

7. What is an SoC?

SoC stands for System on Chip. Silicon devices like Xilinx Virtex™-4 FX FPGAs enable multiple functions that are found in today's electronic systems. Examples include a microprocessor (PowerPC 405), hard-embedded DSP MACs, memory, logic elements and many parallel and serial IO ports that support interface standards such as LVDS and serial IO respectively.

In the context of JTRS SDR SoC these system level features can be employed in many ways. Examples include the following:

- DSP and logic fabric – High sample rate filters, NCO, custom waveforms
- Power PC 405 processor – SCA OE

8. What is the JTRS SDR Kit?

The JTRS SDR kit was developed by ISR Technologies and Xilinx. The kit consists of an SD-IDU (Software Defined Indoor Unit) modem from ISR Technologies instantiating a wideband waveform in a Xilinx Virtex-4 FX FPGA to transmit video data to another SD-IDU. While maintaining transmission of the wideband waveform, the SD-IDU then initiates a narrowband waveform to also transmit voice data to the other SD-IDU. By supporting multiple waveforms in a single FPGA and seamlessly changing waveforms on a dynamic basis without disrupting current waveforms, this powerful technology can significantly lower the cost, power consumption and size of an SDR. Partial reconfiguration of FPGAs is enabling a new model of digital signal processing (DSP), known as a shared resources model, in SDR modems.

Benefits of using the JTRS kit include:

- 2-3X lower system power & BOM cost through:
- SCA SoC technology using Virtex-4 FX FPGAs
- Easier partial reconfiguration of FPGA using new PlanAhead™ 8.1 software
- Rapid verification of military waveforms
- Rapid path from prototyping-to-production

9. How much does the JTRS SDR kit cost?

For $75,000, customers receive the following components:

- HARDWARE
  - 2x Software defined indoor unit (SDR modem)
    - Green Hills Integrity 5
    - OrbExpress Corba 2.6
    - CRC SCA CoreFramework v2.2
  - 2x Laptops
    - Webcams
    - CRC Radio Manager
  - 2x VoIP Phones
  - Cables
  - Documentation
- SOFTWARE
  - Xilinx PlanAhead Hierarchical Floor Planner with Partial Reconfiguration support for Virtex-4
  - Reference Design waveforms
    - System Generator models (source code)
    - FSK narrowband for VoIP, FSK wideband for video
  - CRC Radio Manager (SCA GUI)
  - Run-time software
    - CRC SCA Core Framework v2.2
    - OrbExpress CORBA ORB
    - Green Hills INTEGRITY

All equipment shipped in a rugged black box from ISR Technologies. It includes full documentation including a QuickStart guide for a good out-of-box experience and user manuals. It also includes on-site installation and on-site training on partial reconfiguration under control of the SCA.

10. How can customers order the JTRS SDR kit?

To order, contact ISR Technologies
sales@isr-t.com
(514) 396-8422